

## Efficient Fertilizer storage with the Eurosilos® system

Chris Geijs and Jaap P.J. Ruijgrok, ESI Eurosilos BV, the Netherlands, take a look at fertilizer storage with help of the Eurosilos® system.

### Introduction

With a history of over 40 years and a track record of more than 120 units built around the world, ESI Eurosilos is a leading engineering and contracting company in enclosed storage and handling systems for storing huge quantities of bulk solids to meet the high demand for energy and mineral resources. Non-free flowing products can be stored over longer periods of time with help of a slotted column system for uncomplicated reclaiming. Gypsum is stored this way at numerous power stations around the world. The same system is also a well-proven storage solution for solid fertilizer in granulated form like Ammonium Sulfate, Potash and Common Salt. A recent example of fertilizer storage is the commissioning of a 40,000m<sup>3</sup> Ammonium Sulfate silo in Seoul for the Capro Cooperation, South-Korea.



40,000 m<sup>3</sup> Ammonium Sulfate, South-Korea

During the filling process, the product enters the silo through a hopper mounted in the center of the roof. A short conveyor transfers the bulk material to the telescopic chute. From here, the product can freely drop down towards the auger frame, located at the top surface of the already stored bulk material. An auger conveys the material to the outer edge of the silo. At this point, a sensor is activated, allowing the overhead bridge and suspended auger frame to rotate towards free space and lay down a new segment of bulk material. This process continues for 360 degrees. The winch system (located at the overhead bridge) hoists the auger frame one layer thickness after completing a full rotation. This cycle can be repeated until the silo is completely filled with bulk material.

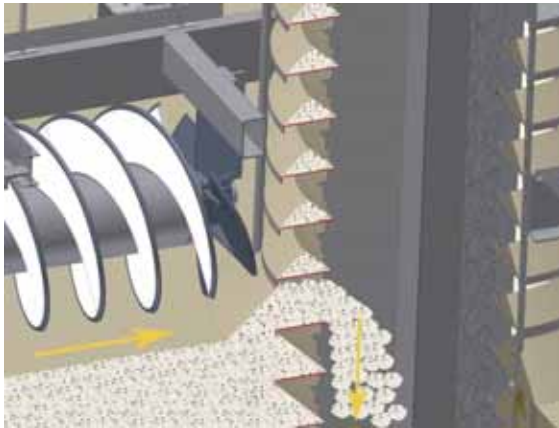


15,000 m<sup>3</sup> Common Salt, The Netherlands

During the discharge process, overhead bridge and suspended auger frame rotate continuously, while two augers dig into the bulk material and transport the product towards the slotted column in the center of the silo. After a full rotation, the auger frame is lowered one layer thickness.

### Eurosilos® system working principle

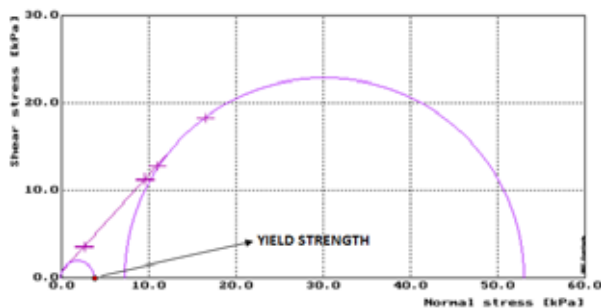
Propellers, located at the end of the augers, push the bulk material along the slots of the column, allowing the product to freely fall down towards an extracting device at the bottom of the silo.



Working principle of the slotted column

### Bulk properties of Ammonium Sulfate in granulated form

Ammonium Sulfate in granulated form is an inorganic salt and mostly used as a soil fertilizer. In the soil the ammonium ion is released, lowering the pH balance of the soil, while contributing essential nitrogen for plant growth. Most of the Ammonium Sulfate is produced as a byproduct during the production of Caprolactam. After production, the Ammonium Sulfate acts like a free flowing product with low yield strength under pressure.



Unconfined Yield strength for Ammonium Sulfate under pressure (shown in Mohr circle diagram)  
 Ammonium Sulfate is a hygroscopic bulk material and crystallizes at room

temperature during storage. This process greatly increases the initial yield strength and can impose bridging problems during discharging after a period of storage in a mass flow silo. The slotted column design of the Eurosilos® system ensures stable storage of the initial low yield strength product and eliminates possible block-ups during discharging after longer periods of storage with help of the digging action of the augers and transportation of the bulk material along the slots by the propellers.

### Design and construction details

The structural design of most Eurosilos® walls for fertilizer storage consists of a steel structure with an inner and outer wall.



Inner wall with ring beams and wooden lining.  
 Outer wall with standard wall cladding

The inner wall consists of wooden planks, connected by tongue and groove. These planks are supported by horizontal ring beams, which take care of the bulk

material forces. In the lower section of the silo wall, the ring beams are placed closer together, because of the higher bulk material forces in this region. The ring beams are connected to the vertical columns by means of a sliding joint. Due to this connection, all horizontal bulk material forces are taken by the ring beams as a tensional force. The ring beams can expand without transferring horizontal forces towards the vertical columns. This flexible wall system is well proven and corrosion resistant.

The silo wall can also be constructed as a concrete structure. In this case, the horizontal bulk forces are taken by the reinforcement. Construction is done with help of a slip form, a method of vertically extruding a reinforced concrete section in a continuous process.



Silo slip form in progress

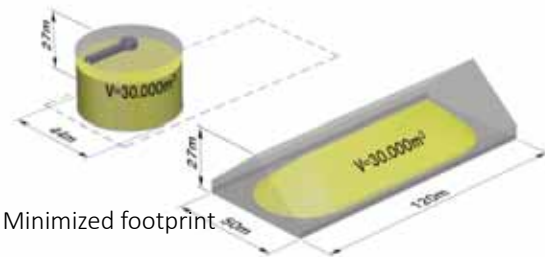
### Storage with a minimal footprint

The Eurosilos® system combines minimum space requirements with large storage capacities. In many cases, existing chemical plants need to expand their storage capacity. Very often however, there is not much space left for the installation of such a new storage system.

Enclosed storage with The Eurosilos® system is very space efficient.

Approximately one third of space is used

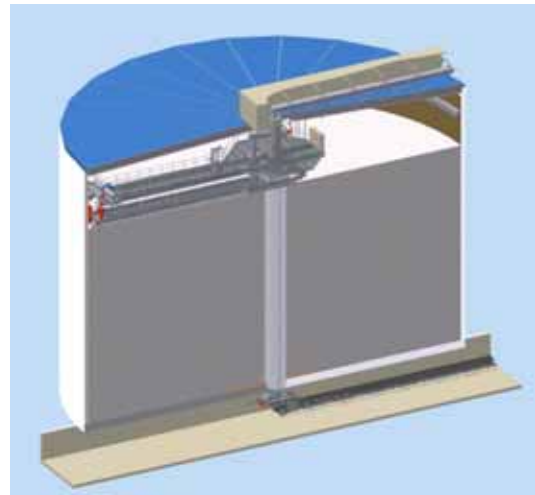
compared to open storage or a storage shed.



Minimized footprint

### Storage of 40,000m<sup>3</sup> Ammonium Sulfate

As mentioned in the introduction, ESI Eurosilos recently commissioned a 40,000 Ammonium Sulfate silo for the Capro Cooperation in Seoul, South-Korea.



3D-Model of 40,000 Ammonium Sulfate silo

This silo is the third installment (1), next to the two existing Eurosilos built in 2001 (2), replacing the currently used conventional storage shed (3) (See figure next page). For this silo a steel structure is used with wooden inner wall and outer standard wall cladding. The vertical columns and bracings are designed to withstand earthquake loads, due to the seismic location of the chemical plant.



Overview silos Capro Cooperation



Steel structure of 40,000 Ammonium Sulfate silo



Eurosilos® system inside the Ammonium Sulfate silo

The different components of the Eurosilos® system were part of a turnkey delivery on site. A temporary opening in the steel wall structure provided access to the silo. With help of a mobile crane, all the components were hoisted into place, after which the construction of the roof was started. The first product entered the silo in the second quarter of 2013.



Product infeed into the silo

It can be concluded that this type of storage is feasible for fertilizer products in a wide variety of situations in which the logistics require substantial storage capabilities. Comparing the total annual costs of silos equipped with the Eurosilos®

system, consisting of capital, maintenance and operating costs, with those of storage in A-frame sheds or even open storage, these mammoth silos are favorable in many cases.

**For further information please contact us**

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